

**50 years of botanical discovery: a golden anniversary edition of *Nuytsia*,
the journal of the Western Australian Herbarium****Juliet A. Wege¹ and Kelly A. Shepherd**

Western Australian Herbarium, Biodiversity and Conservation Science,
Department of Biodiversity, Conservation and Attractions,
Locked Bag 104, Bentley Delivery Centre, Western Australia 6983

¹Corresponding author, email: Juliet.Wege@dbca.wa.gov.au

SHORT COMMUNICATION

Western Australia is environmentally and ecologically diverse with a rich and evolutionarily remarkable flora that is not only of immense scientific interest, but a source of wonder and inspiration. More than 12,800 vascular plant species are recorded for the State (Western Australian Herbarium 1998–), significant numbers of which are endemic, especially in the biodiverse South-West Province (Beard *et al.* 2000; Hopper & Gioia 2004). This exceptional diversity creates a significant challenge with respect to documenting all of the species that occur in Western Australia, including where they grow, when they flower and fruit, and their rarity—a challenge that is exacerbated by a range of factors including the State’s extensive spatial scale, the regular discovery of novel species (many of which are naturally or anthropogenically rare or otherwise of conservation significance), herbarium collection gaps (including the relative dearth of historic type material), and the relatively small number of taxonomists working on the flora compared to the magnitude of the task (Wege *et al.* 2015; Weaver 2017; Decadal Plan Working Group 2018). Nonetheless, enormous taxonomic progress has been made during the past 50 years, in part due to the Western Australian Herbarium’s establishment of the peer-reviewed journal *Nuytsia*.

Nuytsia was launched on 10 December 1970 in response to a pressing need to regularly communicate the large volume of taxonomic and systematic information being produced by staff and associates of the Herbarium. Named after *Nuytsia floribunda* (Labill.) R.Br. ex G.Don (Loranthaceae) (Figure 1), a spectacular arborescent root hemiparasite endemic to south-western Australia and of cultural significance to Noongar Aborigines (Hopper 2010), the journal quickly developed into the quintessential publication outlet for an extensive array of information relevant to Western Australia’s flora and its botanical collections. Since its inception, research activity has not abated, with *Nuytsia* continuing to publish baseline taxonomic information to inform research and conservation efforts across the State and beyond. This year, to mark the journal’s golden anniversary, 50 new Western Australian species from 50 genera will be published on separate days throughout the year, each with corresponding social media. This novel approach was inspired by a previous strategic initiative to name and describe rare, threatened or poorly known taxa (Wege *et al.* 2007, 2015), made possible by our adoption of an electronic publication model following the changes to the *International Code of Nomenclature* that came into effect on 1 January 2012 (McNeill *et al.* 2012), and realised through the concerted efforts of a small team of Herbarium researchers keen to pay homage to the achievements of the journal and its contributors.



Figure 1. Western Australia's iconic Christmas Tree, *Nuytsia floribunda* (Labill.) R.Br. ex G.Don (Loranthaceae). Photograph by K.A. Shepherd.

Since the inaugural paper revising select genera in Rutaceae was published by Wilson (1970), a broad array of scientists, collections staff and associated personnel have added to the growing body of information on Western Australia's flora by writing, reviewing and editing *Nuytsia* manuscripts and curating the associated specimens, achieving a cumulative output that was unimaginable when the journal was founded. Over this time, the number of native vascular plants recorded for Western Australia has risen from 5,802 (Beard 1969) to 10,445 species (Figure 2; or 11,575 taxa as of 31 December 2019), with the names of approximately one-fifth of currently accepted taxa formalised in *Nuytsia*, more than any other publication. *Nuytsia* has also contributed to the globally significant rate of species discovery and description that has recently been highlighted for Australia: for the decade 2006–2015, 1,648 new Australian species were described (31% in *Nuytsia*), placing Australia as one of the top three countries (alongside Brazil and China) for formally naming new plant species (RBG Kew 2016).

The high rate of species discovery and description evident in Western Australia over the past 30 years (Figure 2) has occurred in concert with government-funded floristic surveys at the regional, sub-regional and local scales (e.g. Gibson *et al.* 2007; Keighery *et al.* 2007; McKenzie *et al.* 2009; Markey *et al.* 2012) and surveys by the industry, university and community sectors. These surveys, together with targeted and opportunistic collections by local, national and international taxonomists and systematists, have resulted in significantly more herbarium specimens from a broader range of localities becoming available for study (Figure 3). Improved taxonomic knowledge has in turn driven a marked increase in the number of taxa listed under Conservation Codes for Western Australian Flora (Figure 4)—almost one-third (n. 3,699) of the State's native vascular plant taxa are now conservation-listed, of which 1168 were named in *Nuytsia* (Western Australian Herbarium 1998–; Smith & Jones 2018). Many additional taxa have undergone revised conservation assessments as part of contemporary editorial processes that evaluate all treated taxa against jurisdictional conservation standards (Coates & Atkins 2001; Department of Biodiversity, Conservation and Attractions 2019) to ensure that conservation listings and associated data are up-to-date at the time of publication.

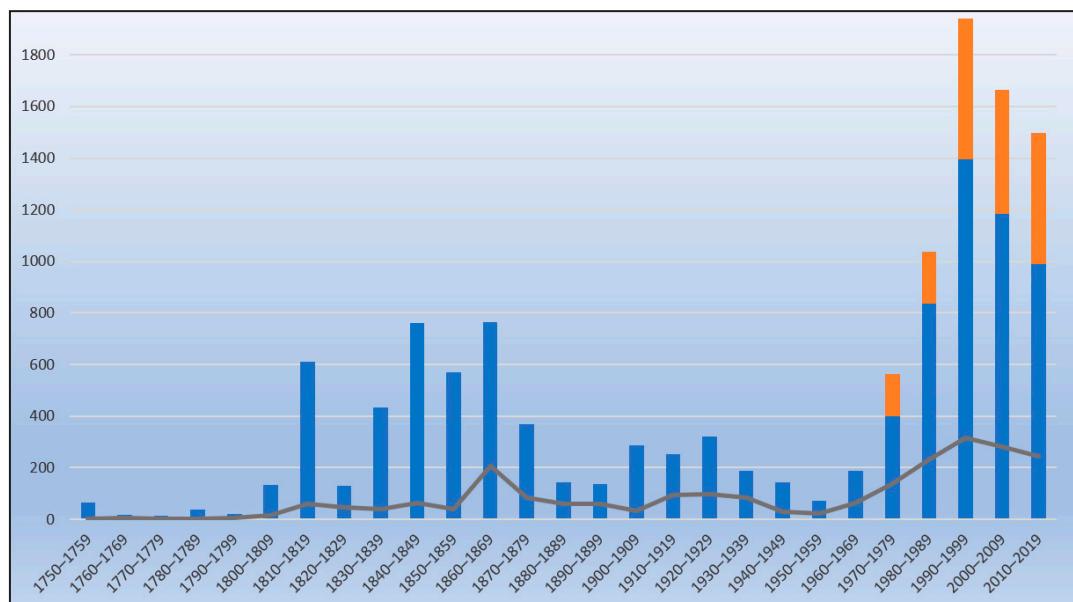


Figure 2. The number of Western Australian native vascular plant species according to the decade the current name was published. The proportion of names published in *Nuytsia* (1970–2019) are indicated by the orange bar, while the number of new combinations (regardless of publication outlet) are indicated by the grey line. Note that the past three decades have been the most prolific in terms of species discovery and description and, while there has been an overall decline in the number of species published since the 1990s, the outputs from *Nuytsia* have remained fairly consistent.

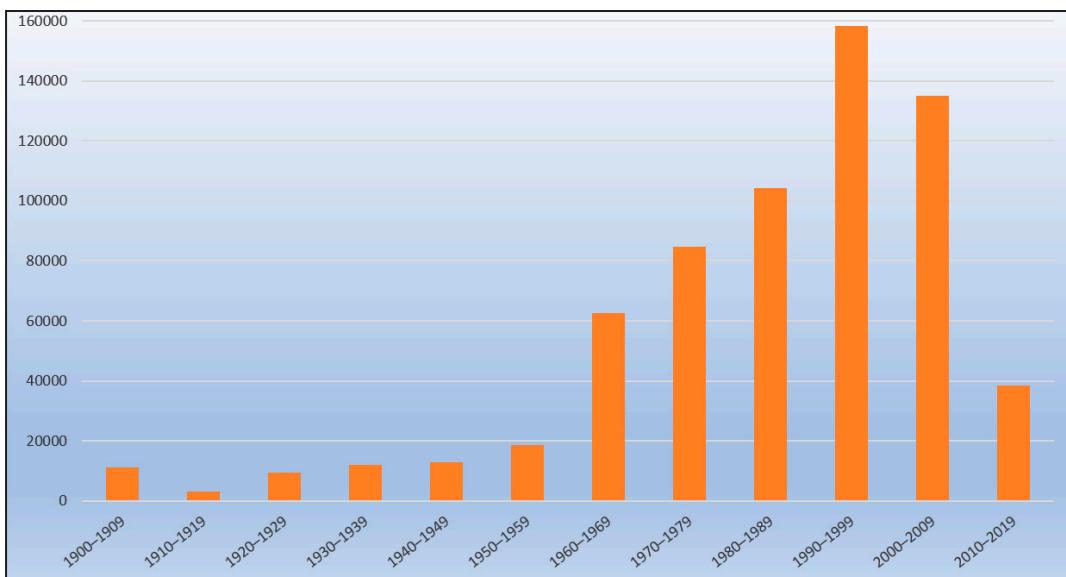


Figure 3. The number of Western Australian vascular plant specimens databased at the Western Australian Herbarium according to their decade of collection (pre-1900 collections, of which there are fewer than 5,000, are not shown). Markedly fewer specimens have been added to the State collection for the decade 2010–2019 as compared with the preceding five decades—a pattern consistent with a world-wide trend.

Despite 50 years of collective taxonomic effort and downstream conservation benefits, we remain faced with enormous challenges that are heightened by the escalating impacts of a broad range of threatening processes. A substantial taxonomic backlog of 1,194 undescribed (informally-named) vascular plant taxa remain recognised on Western Australia’s vascular plant census (Western Australian Herbarium 1998–), a number that has not significantly decreased in the past 15 years despite sustained taxonomic research (Figure 5). Furthermore, while targeted efforts to reduce the number of undescribed Threatened (Critically Endangered, Endangered or Vulnerable) taxa have been successful (decreasing from 50 in 1999 to 21 in 2019, although with a total of 108 Threatened taxa newly named during this period), the total number of undescribed, conservation-listed taxa has increased from 485 to 584 (Figure 4). This largely reflects the high rate of species discovery in Western Australia, and the fact that newly discovered taxa are more likely to be uncommon and ‘Data Deficient’ (Priority One to Priority Three under Conservation Codes for Western Australian Flora) (Wege *et al.* 2015).

Resolving the taxonomy of undescribed taxa, and indeed the discovery of new taxa, is often hampered by the absence of an overarching Flora of Western Australia with up-to-date descriptive, distributional and ecological data for known species, and associated identification guides. Moreover, as many putatively new taxa are poorly known and represented by few herbarium specimens, additional collections are often required to inform taxonomic decision-making or serve as type material. It is therefore disquieting that markedly fewer specimens have been added to the State collection for the decade 2010–2019 as compared with the preceding five decades (Figure 3). This pattern, which is expected to remain largely unchanged even once collection backlogs are processed, is consistent with a world-wide trend (Decadal Plan Working Group 2018) and could have flow-on effects. There is a risk that undescribed species—or some of the many formally described but ‘Data Deficient’ taxa (Figure 4)—will go extinct before they are adequately described or their conservation status determined, which may be the case for a new native grass species to be described in *Nuytsia* later this year. But, as this anniversary edition of *Nuytsia* demonstrates, significant biodiversity conservation outcomes can be

achieved through teamwork, targeted collecting efforts, and the support of local conservation personnel, industry consultants and citizen scientists.

We have drawn on existing and burgeoning taxonomic expertise at the Western Australian Herbarium to produce this anniversary edition, with staff forming new collaborations with one another, or with Herbarium Associates or botanists based elsewhere in Australia. The 50 included species are found in a range of habitats—from the Kimberley to the south coast, including the Perth region and some of the State’s most iconic National Parks—and are mostly vascular plants, although two species of algae and one slime mould have been included to highlight ongoing research on these groups. Twenty-two species were first collected or otherwise brought to light within the past two decades, in many cases through surveys of mineral leases or the opportunistic collections of keen-eyed botanists and citizen scientists. Conversely, 17 species were first collected more than 50 years ago but have remained undocumented, in some cases due to the need for additional collections and data that have only recently been obtained. Most importantly, by adopting the prioritisation methodology outlined by Wege *et al.* (2015), the taxonomy of 42 conservation-listed species will be resolved. Among them are four Threatened and 21 Priority One species, some of which are known only from a single herbarium gathering or population, or fewer than 50 individuals. Giving scientific names to these species and providing descriptions to aid their identification is a critical step that is likely to stimulate surveys and herbarium vouchering, and lead to positive conservation outcomes such as the discovery of new populations.

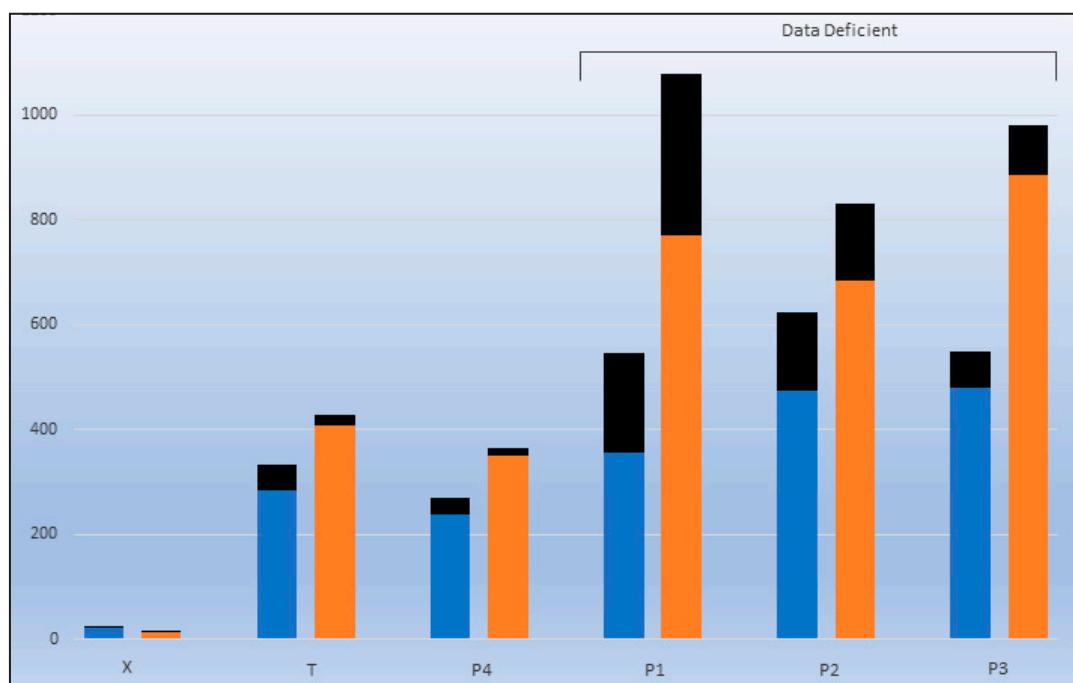


Figure 4. A comparison of the number of taxa in each of Western Australia’s conservation categories in 1999 (blue bars) and 2019 (orange bars), with the proportion of undescribed (informally-named) taxa indicated in black. X = Extinct, T = Threatened (Critically Endangered, Endangered or Vulnerable), P4 = Priority Four (equivalent to IUCN (2012): ‘Near Threatened’), P1–P3 = Priority One–Three (equivalent to IUCN (2012): ‘Data Deficient’). The number of taxa in each category (except for Extinct) has increased over the past two decades, largely due to improved taxonomic knowledge. Almost a third (n. 3,699) of the State’s native vascular plant taxa are now conservation-listed (Western Australian Herbarium 1998–), up from 2,340 in 1999 (Atkins 1999), presenting an enormous conservation challenge. While the number of undescribed taxa in the Threatened and Priority Four categories has decreased, partly as a result of strategic efforts (Wege *et al.* 2015), the number of undescribed ‘Data Deficient’ taxa has increased from 409 to 584, largely reflecting high rates of species discovery.

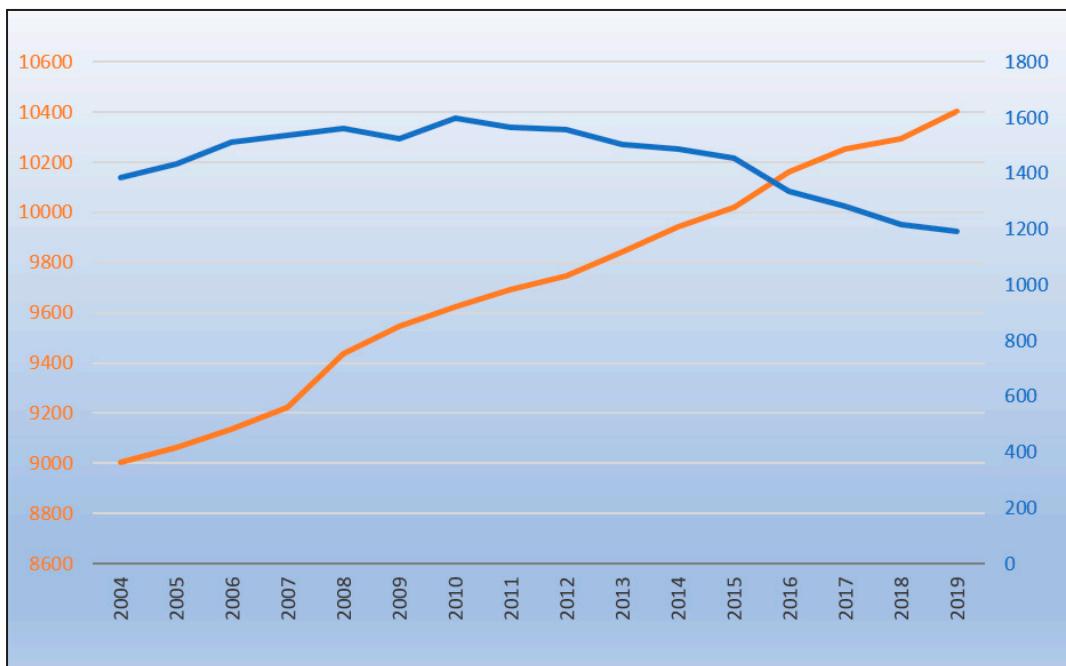


Figure 5. Changes to the number of formally-named (orange) and informally-named (blue) native species recognised on Western Australia's vascular plant census over the past 15 years (Western Australian Herbarium 1998–). While the number of formally-named species has risen steadily, the number informally-named (undescribed) taxa has not decreased to the same extent, reflecting high rates of species discovery through survey and taxonomic assessment of herbarium collections.

The bold agenda for documenting Australia's biodiversity proposed by the Decadal Plan Working Group (2018), which includes the description of all vascular plant taxa by 2028, remains a challenging proposition amid the concomitant need to build a digital Flora of Western Australia. While advances in genomics and bioinformatics will continue to provide increasing amounts of novel data to inform species discovery and taxonomic decision making, *Nuytsia* will remain at the vanguard of conservation efforts in Western Australia for the foreseeable future, advancing knowledge of the State's flora—in the case of this 50-year anniversary edition, by describing one species at a time.

Acknowledgements

We thank staff and associates of the Western Australian Herbarium, external collaborators, reviewers and artists for their valued scientific contributions to this anniversary edition; the PERTH collections team for their tremendous support, especially Julia Percy-Bower for efficiently managing specimen flows and data requests, and Meriel Falconer for her cited specimen audits; Ryonen Butcher for copy-checking manuscripts; Melanie Smith and Anthea Jones for conservation-related advice; and the wide variety of botanists who have contributed to this volume by collecting herbarium vouchers, including but not limited to current and former DBCA staff, industry consultants and volunteers. We acknowledge Margaret Byrne, Stephen van Leeuwen, Colin Yates and John Huisman for their support of this initiative and funding from DBCA Biodiversity Science and Conservation that enabled some of the included research to be completed.

References

Atkins, K.J. (1999). *Declared Rare and Priority Flora list for Western Australia*. (Department of Conservation and Land Management: Kensington, Western Australia.)

Beard, J.S. (1969). Endemism in the Western Australian flora at the species level. *Journal of the Royal Society of Western Australia* 52: 18–20. <https://biodiversitylibrary.org/page/46129166>

Beard, J.S., Chapman, A.R. & Gioia, P. (2000). Species richness and endemism in the Western Australian flora. *Journal of Biogeography* 27: 1257–1268.

Coates, D.J. & Atkins, K.A. (2001). Priority setting and the conservation of Western Australia's diverse and highly endemic flora. *Biological Conservation* 97: 251–263.

Decadal Plan Working Group (2018). *Discovering biodiversity: a decadal plan for taxonomy and biosystematics in Australia and New Zealand 2018–2027*. (Australian Academy of Science: Canberra.)

Department of Biodiversity, Conservation and Attractions (2019). *Conservation Codes for Western Australian flora and fauna*. Available at <https://www.dpaw.wa.gov.au/images/documents/plants-animals/threatened-species/Lists/Conservation%20code%20definitions.pdf> [accessed 31 December 2019].

Hopper, S.D. (2010). 660. *Nuytsia floribunda*. Loranthaceae. *Curtis's Botanical Magazine* 26(4): 333–368.

Hopper, S.D. & Gioia, P. (2004). The Southwest Australian Floristic Region: evolution and conservation of a global hot spot of biodiversity. *Annual Review of Ecology, Evolution and Systematics* 35: 623–650.

Gibson, N., Coates, D.J. & Thiele, K.R. (2007). Taxonomic research and the conservation status of flora in the Yilgarn Banded Iron Formation ranges. *Nuytsia* 17: 1–12.

IUCN (2012). *IUCN Red List Categories and Criteria: Version 3.1*. 2nd edn. IUCN Species Survival Commission. (IUCN: Gland, Switzerland & Cambridge, United Kingdom.)

Keighery, G.J., Gibson N., van Leeuwen, S., Lyons, M.N. & Patrick, S. (2007). Biological survey and setting priorities for flora conservation in Western Australia. *Australian Journal of Botany* 55: 308–315. <https://doi.org/10.1071/BT06102>.

Markey, A., Kern, S. & Gibson, N. (2012). Floristic communities of the Ravensthorpe Range, Western Australia. *Conservation Science Western Australia* 8: 187–239.

McKenzie, N.L., van Leeuwen, S. & Pinder A.M. (2009). Introduction to the Pilbara Biodiversity Survey, 2002–2007. *Records of the Western Australian Museum, Supplement* 78: 3–89.

McNeill, J., Barrie, F.R., Buck, W.R., Demoulin, V., Greuter, W., Hawksworth, D.L., Herendeen, P.S., Knapp, S., Marhold, K., Prado, J., Prud'homme, van Reine W.F., Smith, G.F., Wiersema, J.H. & Turland, N.J. (eds) (2012). *International Code of Nomenclature for algae, fungi, and plants (Melbourne Code) Adopted by the Eighteenth International Botanical Congress Melbourne, Australia, July 2011*. (Koeltz: Konigstein, Germany.)

RBG Kew (2016). *The state of the world's plants report – 2016*. (Royal Botanic Gardens, Kew: London.) https://stateoftheworldsplants.org/2016/report/sotwp_2016.pdf

Smith, M.G. & Jones, A. (2018). *Threatened and Priority Flora list 16 January 2018*. Department of Biodiversity, Conservation and Attractions. <https://www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities/threatened-plants> [accessed 31 December 2019].

Weaver, H.J. (2017). *State of the science of taxonomy in Australia: results of the 2016 survey of taxonomic capacity, Commonwealth of Australia 2017*. (Australian Biological Resources Study: Canberra.)

Wege, J.A., Shepherd, K.A. & Butcher, R. (2007). *Preface to Nuytsia 17: Saving our Species* special edition.

Wege, J.A., Thiele, K.R., Shepherd, K.A., Butcher, R., Macfarlane, T.D. & Coates, D.J. (2015). Strategic taxonomy in a biodiverse landscape: a novel approach to maximizing conservation outcomes for rare and poorly known flora. *Biodiversity and Conservation* 24(1): 17–32. doi: 10.1007/s10531-014-0785-4.

Wilson, P.G. (1970). A taxonomic revision of the genera *Crowea*, *Eriostemon* and *Phebalium* (Rutaceae). *Nuytsia* 1(1): 3–155.

Western Australian Herbarium (1998–). *FloraBase—the Western Australian Flora*. Department of Biodiversity, Conservation and Attractions. <https://florabase.dpaw.wa.gov.au/> [accessed 31 December 2019].

